REMARKS

The present invention provides photoresist compositions that are suitable for use in photolithography at wavelengths less than about 248 nm. Applicant has discovered that employing large amounts of a photo acid generator (PAG) and a base additive, and more particularly, large amounts of the base additive relative to the PAG in a photoresist composition of the invention can advantageously result in significantly reduced line edge roughness when the photoresist is exposed to radiation. As discussed below, none of the references cited in the Office Action, either individually or in combination, recognizes the problems associated with line edge roughness in photolithography at wavelengths below about 248 nm. And none of the references provides solutions, such as those provided by the Applicant, for solving these problems.

Claim Objections

In response to the objection raised in Paragraph 16 of the Office Action, claim 18 is amended to recite "A photoresist having *a* micron or submicron linewidth variation ..."

In response to the objections raised in Paragraph 17 of the Office Action, independent claims 18, 20, and 25 have been amended, in accordance with the Examiner's recommendation, to recite "... micron or submicron linewidth variation when *exposed to* radiation having a wavelength of about 248 nm or less...."

Rejections Under 35 U.S.C. 112

The Office Action rejects claims 18-28 as being indefinite. As discussed below, amendments presented with this response are believed to overcome these rejections.

In particular, independent amended claim 18 recites that the base has a molar concentration ratio in a range of about 0.5 to 1.5 relative to the photoacid generator, and amended claim 19 recites a range of about 0.2 to 1.5 for the molar concentration ratio of the base

relative to the photoacid generator. In addition, independent claim 20 recites a molar concentration ratio in a range of about 0.5 to 1.5 for the base relative to the PAG, and amended claim 25 recites a molar concentration ratio of about 0.5 to 1.5.

The specification provides ample support for the ranges recited for the molar concentration ratio of the base relative to the PAG in the above amended claims. For example, on page 3, the specification recites that the "molar concentration ratio of the base to the PAG is at least 0.2," and that the "molar concentration ratio of the base to the PAG is preferably less than about 1.5," and "more preferably, the molar concentration ratio of the base to the PAG is less than about 1." Further, on page 5, the specification recites that more preferably, "the base to PAG molar concentration ratio is in a range of about 0.3 to about 0.8, and most preferably in range of about 0.4 to about 0.6."

Further, the molar concentration ratio of the base relative to the PAG in the photoresist composition designated as "Resist 99071" in Example 1 (Table 1) is 0.481, the base to PAG molar ratio for the photoresist composition designated as "Resist 99100" in Example 2 (Table 3) is 0.547, the base to PAG molar ratio for the composition designated as "Resist 99101" in Example 3 (Table 5) is 0.492, and the corresponding base tc PAG ratio for the photoresist composition designated as "Resist 99107" in Example 5 (Table 9) is 0.534. These exemplary values for the base to PAG molar ratio can be rounded off to 0.5.

Each of the above ranges for the molar concentration ratio of the base relative to the PAG in a photoresist of the invention clearly defines a range for the ratio of the base concentration relative to the concentration of the photoacid generator constituent of the resist, thereby overcoming the 112 rejections.

Rejections Under 35 U.S.C. 103

The Office Action rejects claims 18-24 as being obvious in view of U.S. Patent No. 6,306,554 of Barclay. As discussed in detail below, amended claims 18-24 distinguish patentably over the teachings of Barclay.

In particular, amended claim 18 recites a photoresist composition that exhibits micron or submicron linewidth variation when exposed to radiation having a wavelength of about 248 nm or less, and includes a polycyclic copolymer, a photoacid generator and a base having a molar concentration ratio in a range of about 0.5 to 1.5 relative to the photoacid generator.

Barclay is understood to describe photoresist compositions having polymer resins that contain heterocyclic rings. The photoresist compositions of Barclay, in addition to a resin binder, can include a photoacid generator and a base additive. Barclay generally recites that the added base is used in relatively "small amounts, e.g., about 0.03 to 5 percent by weight relative to the total solids." Further, in Example 7, Barclay recites exemplary concentration values of the photoacid generator and the base, which translate to a molar ratio of 0.1 for the base relative to the photoacid generator, which is significantly lower than values taught by the invention. In fact, there is no teaching or recognition in Barclay regarding selecting the molar ratio of the base to the photoacid generator to be in a particular range so as to ensure that photoresist composition would exhibit micron or submicron linewidth variation when exposed to radiation.

The Examiner appears to have selected the value of the concentration of the photoacid generator in Example 7 of Barclay and, armed with the teachings of the invention, to have selected a range of base concentrations from the large range of 0.03 to 5 percent by weight described by Barclay to obtain the base to PAG ratios taught by the invention. This, however, amounts to impermissible hindsight! Applicant notes in this regard that The Court of Appeals for the Federal Circuit (CAFC) has repeatedly admonished that the Examiner may not "use the claimed invention as an instruction manual or 'template' to piece together the teachings of the prior art so that the claimed invention is rendered obvious." *In re Fritch*, 972 F.2d 1260, 1266, 23 USPQ2d 1780, 1783-84 (Fed. Cir. 1992).

In the present case, Barclay is not concerned with minimizing the line edge roughness of a photoresist composition upon exposure to radiation. And hence, Barclay does not teach or suggest utilizing high base to PAG ratios to decrease such line edge roughness. Hence, there is no motivation for one of the ordinary skill in the art to select a particular concentration of PAG in Barclay, and a particular sub-set of a large range of the base concentration described in

Barclay in order to obtain the high base to PAG concentration ratios taught by the present invention.

In contrast, claim 18 expressly recites that the base has a molar concentration ratio relative to the PAG that is in a range of about 0.5 to 1.5. Thus, claim 18 distinguishes patentably over the teachings of Barclay.

Independent amended claim 19 recites a photoresist composition that includes a photoresist polymer, a photoacid generator, and a base additive. Further, claim 19 recites that the photoacid generator has a concentration of *at least 6 percent* by weight, and the base has a molar concentration ratio in a range of about 0.2 to 1.5 relative to the photoacid generator.

Barclay does not teach or suggest the high concentrations of the PAG recited in amended claim 19. In fact, the only teachings in Barclay regarding the PAG concentration is a general statement in col. 14, lines 61-65, that a photoacid generator "is suitably employed in an amount sufficient to generate a latent image in a coating layer of the resist upon exposure to activating radiation," and values recited in a few examples, all of which fall significantly below the PAG concentration range recited in claim 19. Neither does Barclay provide any suggestion or motivation for selecting the range of the base to PAG ratios recited in claim 19. Hence, claim 19 distinguishes patentably over the teachings of Barclay.

Independent claim 20, which recites a photoresist composition having a cycloolefin based polymer or copolymer, a photoacid generator and a base, has been amended to recite that the base has a molar concentration in a range of about 0.5 to 1.5 relative to photoacid generator. As discussed in detail above in connection with claim 18, Barclay does not teach or suggest selecting such a range of molar ratios for the base concentration relative to the PAG concentration. Hence, similar to claim 18, claim 20 is patentable over the teachings of Barclay.

Claims 21-24 depend on claim 20, and hence incorporate the patentable features of this claim. Accordingly, these claims also distinguish patentably over Barclay.

In Paragraph 22, the Office Action rejects claims 18-21, 23, and 24 as being obvious in view of the combined teachings of Barclay and U.S. Patent No. 5,879,856 of Thackeray.

As discussed above, Barclay does not teach or suggest the range of values recited in claim 18 for the concentration of the base relative to the PAG. Further, Thackeray does not teach or suggest a range of about 0.5 to 1.5 recited in amended claim 18 for the relative ratio of the base to the PAG concentrations. More particularly, Thackeray describes photoresist compositions that can include a resin binder having photoacid labile groups, an acid generator, and a photospeed control agent, which can be a base. Thackeray recites that the "photospeed control agent can be employed in relatively small amounts, e.g., about 1% to 20% by weight relative to the PAG." This range of the photospeed concentration relative to the PAG is, however, less than the lower limit, i.e., about 0.5, of the range recited in amended claim 18. Thus, claim 18 distinguishes patentably over the combined teachings of Barclay and Thackeray.

Moreover, the combined teachings of Barclay and Thackeray fails to teach or suggest the high concentration of the PAG, i.e., a concentration of at least about 6 percent by weight, coupled with a range of about 0.2 to 1.5 for the base to PAG concentration ratio recited in amended claim 19. Thus, claim 19 is patentable over the combined teachings of Barclay and Thackeray.

The arguments presented above with respect to claim 18 apply with equal force to establish that amended independent claim 20, and claims 21, 23 and 24, which depend on claim 20, distinguish patentably over the combined teachings of Barclay and Thackeray.

In Paragraph 23, the Office Action rejects claims 25-28 as being unpatentable over Barclay in view of Published Application No. WO 00/67072 of Feiring et al.

Neither Barclay nor Feiring teaches or suggests the high PAG concentration of at least about 6 percent, combined with the base to PAG molar concentration ratio in a range of about 0.2 to 1.5, recited in claim 19. Hence, the combined teachings of Barclay and Feiring fails to teach or suggest the photoresist compositions recited in claim 25, and their associated advantages. Hence, independent claim 25, and claims 26-28 dependent on claim 25, are patentable over the combined teachings of Barclay and Feiring.

In Paragraph 24, the Office Action rejects claims 25, 26, and 28 as being unpatentable over Barclay et al. in view of Thackeray and Feiring. The arguments presented above apply with

equal force to establish that independent claim 25, and claims 26 and 28 dependent on claim 25, distinguish patentably over the combined teachings of Barclay, Thackeray and Feiring. In particular, the combined teachings of these references fails to teach or suggest a base to PAG concentration ratio in a range of about 0.5 to 1.5, as recited in claim 25.

New Claims

New claim 50 recites a photoresist having a micron or submicron linewidth variation when exposed to radiation having a wavelength of about 248 nm or less that can include a polymer or copolymer containing a fluorinated alcohol substituted polycyclic ethylinically unsaturated monomeric unit, a photoacid generator having a concentration of at least 6 percent by weight, and a base having a molar concentration in a range of about 0.2 to 1.5 relative to the photoacid generator.

As discussed above, none of the references, individually or in combination, teaches or suggests a photoresist composition having the combined features of a high PAG concentration of at least about 6 percent by weight and a base molar concentration in a range of about 0.2 to 1.5 relative to the concentration of the photoacid generator. Thus, new claim 50, and claim 51 dependent thereon, are patentable over the cited references.

Moreover, new claim 52 depends on claim 18, and further narrows the range of the concentration ratio of the base relative to the photoacid generator from about 0.5 to 1.5, recited in claim 18, to about 0.6 to 1.5. Claim 52 is patentable for the same reasons presented above in order to establish the patentability of claim 18.

CONCLUSION

In view of the above amendments and remarks, the present application is believed to be in condition for allowance. Hence, reconsideration and allowance of the application are respectfully requested. If there are any remaining issues, Applicant invites the Examiner to call the undersigned at (617-439-2514) to expedite the prosecution of the Application.

Dated: January 9, 2003

Respectfully submitted,

By _____

Reza Mollaaghababa
Registration No.: 43,810
NUTTER MCCLENNEN & FISH LLP
World Trade Center West
155 Seaport Boulevard
Boston, Massachusetts 02210-2604
(617) 439-2514
(617) 310-9514 (Fax)
Attorneys for Applicant

Version With Markings to Show Changes Made

18. (Amended) A photoresist having a micron or submicron linewidth variation when [developed by] exposed to radiation having a wavelength of about 248 nm or less, comprising a polycyclic copolymer, a photoacid generator and a base having a molar concentration ratio in a range of about [of at least about 0.2] 0.5 to 1.5 relative to the photoacid generator.

19. (Amended) A photoresist composition, comprising

a photoresist polymer,

a photoacid generator, and

a base additive,

wherein the photoacid generator has a concentration of at least about 6 percent by weight and the base has a molar concentration ratio [sufficient] in a range of about 0.2 to 1.5 relative to the photoacid generator to buffer acid generated by the photoacid generator upon exposure of the composition to radiation having a wavelength of less than about 248 nm, thereby providing a photoresist with reduced linewidth variation.

20. (Amended) A photoresist having micron or submicron linewidth variation when [developed by] exposed to radiation having a wavelength of about 248 nm or less, comprising

a cycloolefin based polymer or copolymer, a photoacid generator and a base having a molar concentration [of at least 0.2] in a range of about 0.5 to 1.5 relative to the photoacid generator.

21. (Amended) The photoresist of claim 20, wherein the molar concentration ratio of the base relative to the photoacid generator is [at least 0.4] in a range of about 0.6 to 1.5.

22. (Amended) The photoresist of claim 20, wherein the molar concentration ratio of the base relative to the photoacid generator is [at least about 0.6] in a range of about 1 to 1.5.

23. (Amended) The photoresist of claim 20, wherein the molar concentration ratio of the base relative to the photoacid generator is [less than about 1] in a range of about 0.6 to about 1.0.

25. (Amended) A photoresist having micron or submicron linewidth variation when [developed by] exposed to a wavelength of about 248 nm or less, comprising

a polymer or copolymer containing fluorinated alcohol substituted polycyclic ethylinically unsaturated monomeric unit, a photoacid generator and a base having a molar concentration ratio [of at least 0.2] in a range of about 0.5 to 1.5 relative to the photoacid generator.

26. (Amended) The photoresist of claim 25, wherein the molar concentration ratio of the base relative to the photoacid generator is [at least 0.4] in a range of about 0.6 to 1.5.

27. (Amended) The photoresist of claim 25, wherein the molar concentration ratio of the base relative to the photoacid generator is [at least 0.6] in a range of about 1 to 1.5.

28. (Amended) The photoresist of claim 25, wherein the molar concentration ratio of the base relative to the photoacid generator is [less than about 1] in a range of about 0.6 to about 1.

50. (New) A photoresist having micron or submicron linewidth variation when exposed to radiation having a wavelength of about 248 nm or less, comprising

a polymer or copolymer containing a fluorinated alcohol substituted polycyclic ethylinically unsaturated monomeric unit, a photoacid generator having a concentration of at least about 6 percent by weight and a base having a molar concentration ratio of in a range of about 0.2 to 1.5 relative to the photoacid generator.

51. (New) The photoresist of claim 50, wherein the photoacid generator has a concentration in a range of about 6 percent to about 50 percent by weight.

52. (New) The photoresist of claim 18, wherein the molar concentration ratio of the base relative to the photoacid generator is in a range of about 0.6 to 1.5.